Chapter 1- Electric charges and fields

1.What do you mean by quantisation of charge

Charge of a body is always an integral multiple of one electronic charge

$Q=\pm ne$ where $n=1,2,3$.......

2.State coulomb's law.

The force of attraction or repulsion between two stationary electric charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.

Force between two stationary charges in free space $\boxed{F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}}$

3.Define electric field.

Electric field is the region around a charge where its effect can be felt.

$$E = \frac{F}{q}$$

4. Write the unit of electrc field.

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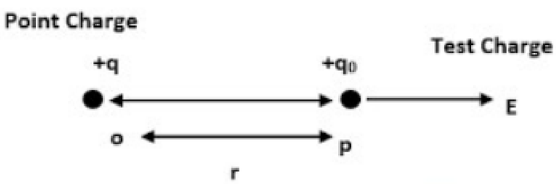
Unit of electric field is N/C or V/m.

5. Derive the equation for Electric field due to a point charge



By Coulomb's law

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q\, q_0}{r^2}$$

$$E = \frac{F}{q_0}$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$$

6.Write any four properties of Electric Electric Field Lines

(i)Electric Field lines tart from positive charge, end at negative charge.

(ii) Electric field lines of a positive charge are radially outwards and that of a negative charge is radially inwards

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(iii) Electric field lines Do not form closed loops.

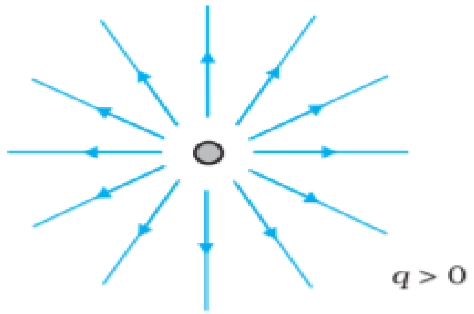
(iv) In a charge free region Field lines are continuous.

(v) Two field lines never intersect.(two directions for electric field is not possible at a point)

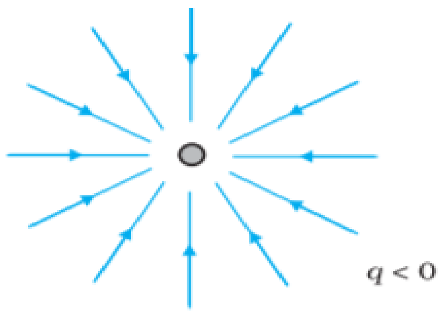
(vi) Field lines are parallel ,equidistant and in same direction in uniform electric field.

(vi) Field lines are parallel ,equidistant and in same direction in uniform electric field.

7.Draw the electric field lines of a positive charge



8.Draw the electric field lines of a negative charge



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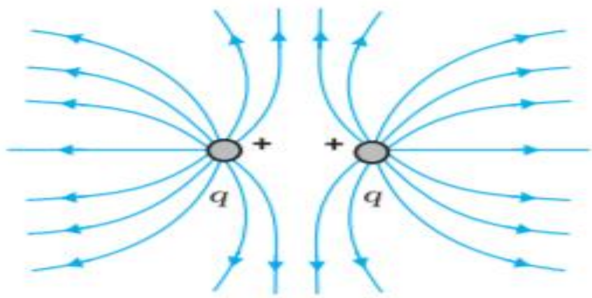
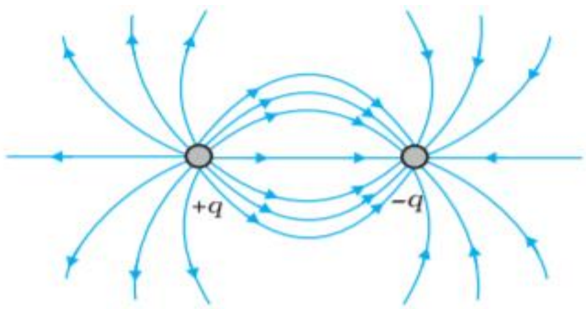
9.Draw the electric field lines of two positive charges



10.Draw the electric field lines of a dipole



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11.Define Electric Flux. Write its unit.

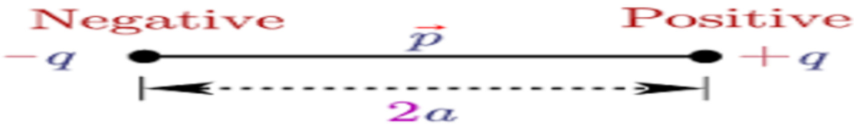
The electric flux associated with a surface is the number of electric field lines passing normal through a surface.

$$\phi = \int E \cdot dS$$

- Unit – Nm^2 / C

12.Define electric dipole

An electric dipole is a pair of equal and opposite point charges separated by a distance.



13.Define electric dipole moment. Write its unit

Electric Dipole moment(p) is the product of magnitude of one of the charges and the distance between charges.

$\boxed{p = q \times 2a}$

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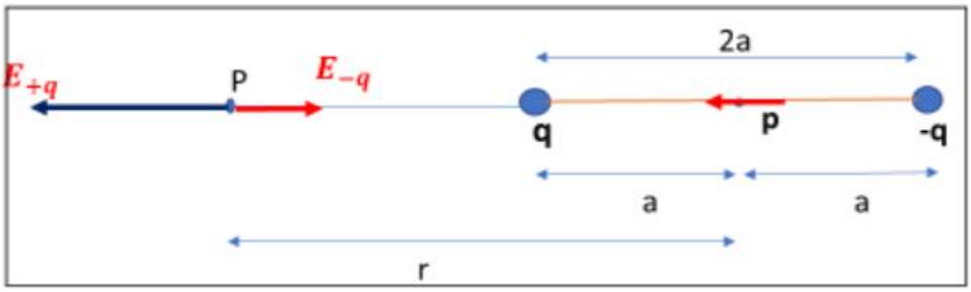
Unit of dipole moment is Cm

14.Derive the equation for electric field due to a dipole along the axial line



The electric field at P due to positive charge is

$$E_{+q} = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r-a)^2}$$ In the direction of dipole moment p

The electric field at P due to negative charge is

$$E_{-q} = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+a)^2}$$ Opposite to the direction of dipole moment p

$$E = E_{+q} - E_{-q} = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r-a)^2} - \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+a)^2}$$

Simplifying

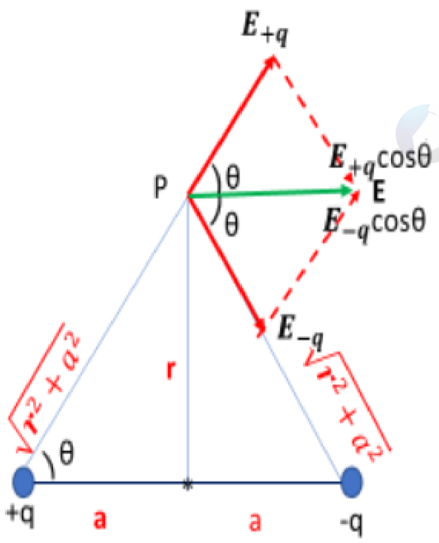
$$\vec{E} = \frac{q}{4\pi\varepsilon_0}\left[\frac{4ar}{(r^2 - a^2)^2}\right]$$

For r >> a, we get $\vec{E} = \frac{1}{4\pi\varepsilon_0}\left[\frac{4qa}{r^3}\right]$.

$$\boxed{\vec{E} = \frac{1}{4\pi\varepsilon_0}\left[\frac{2p}{r^3}\right]}$$

15.Obtain the equation for electric field due to a dipole along its equatorial line

Electeic field along the equatorial line of a dipole



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The magnitudes of the electric fields due to charge +q

$$E_{+q} = \frac{1}{4\pi\varepsilon_0}\,\frac{q}{r^2 + a^2}$$

The magnitudes of the electric fields due to charge -q

$$E_{-q} = \frac{1}{4\pi\varepsilon_0}\,\frac{q}{r^2 + a^2}$$

The total electric fiels

$$E = E_{+q}\cos\theta + E_{-q}\cos\theta$$

But $E_{+q} = E_{-q}$

$$E = 2E_{+q}\cos\theta \longrightarrow (1)$$

$$\cos\theta = \frac{a}{\sqrt{r^2 + a^2}}$$

Substituting in equation (1)

$$E = 2\,\frac{1}{4\pi\varepsilon_0}\,\frac{q}{r^2+a^2}\,\frac{a}{\sqrt{r^2+a^2}}$$

Simplifying we get

$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\,\frac{p}{r^3}}$$

16.State Gauss's Theorem

Gauss's theorem states that the total electric flux through a closed surface is equal to $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface.

$$\phi = \oint E \cdot dS = \frac{q}{\varepsilon_0}$$

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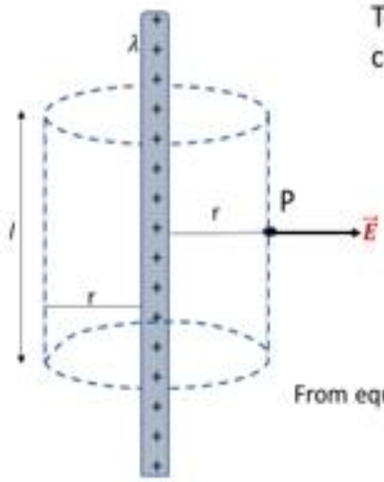
17.Derive the equation for electirc field due to a uniformly charged infinitely long wire



To find the electric field at point P at distance r consider cylindrical Gaussian surface of radius r

$$\phi = E\,S$$

$$\phi = E \times 2\pi r l \longrightarrow (1)$$

By Gauss's law $\phi = \dfrac{q}{\varepsilon_0}$

$\lambda = \dfrac{q}{l}$

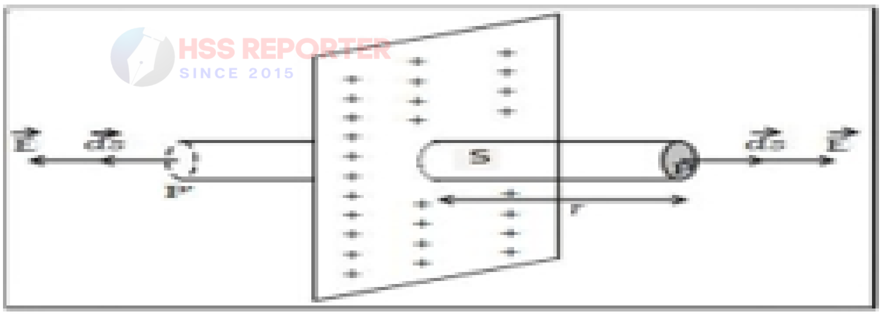
$q = \lambda l$

$$\phi = \frac{\lambda l}{\varepsilon_0} \longrightarrow (2)$$

From equations (1) and (2) $\quad E \times 2\pi r l = \dfrac{\lambda l}{\varepsilon_0}$

$$\boxed{E = \frac{\lambda}{2\pi r \varepsilon_0}} \qquad E \alpha \frac{1}{r}$$

18.Derive the equation for electric field due to a uniformly charged infinite plane sheet



The field lines crosses only the 2 end faces of the Gaussian surface. So the flux through the Gaussian surface

$$\Phi = 2\,E\,S \text{ ------------------ } (1)$$

By Gauss law

$$\Phi = \frac{q}{\varepsilon_0} \qquad (\sigma = q/S)$$

$$\Phi = \frac{\sigma\,S}{\varepsilon_0} \text{ ----------------------- } (2)$$

From equations (1) and (2)

$$2\,E\,S = \frac{\sigma\,S}{\varepsilon_0}$$

$$\boxed{E = \frac{\sigma}{2\varepsilon_0}}$$

Electric field is independent of distance r

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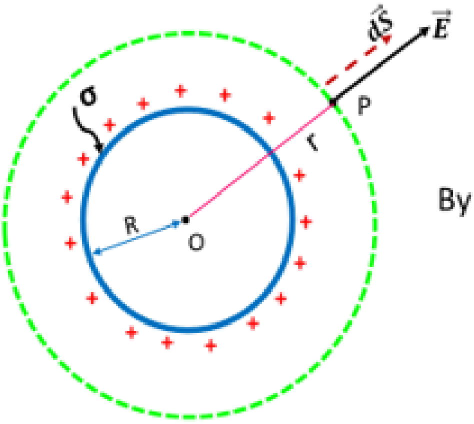
19.Derive the equation for electric field due to a uniformly charged spherical shell



a) Field outside the shell

$$\phi = ES$$

$$\phi = E \times 4\pi r^2 \longrightarrow (1)$$

By Gauss's law $\phi = \frac{q}{\varepsilon_0}$

$$\sigma = \frac{q}{A}$$
$$q = \sigma A$$

$$\phi = \frac{\sigma A}{\varepsilon_0}$$

$$\phi = \frac{\sigma \times 4\pi R^2}{\varepsilon_0} \longrightarrow (2)$$

From equations (1) and (2) $E \times 4\pi r^2 = \frac{\sigma \times 4\pi R^2}{\varepsilon_0}$

$$\boxed{E = \frac{\sigma R^2}{\varepsilon_0 r^2}}$$

$$E \propto \frac{1}{r^2}$$

b) field on the surface of the shell

On the surface of shell $r = R$

$$E = \frac{\sigma R^2}{\varepsilon_0 r^2}$$

$$\boxed{E = \frac{\sigma}{\varepsilon_0}}$$

E is maximum at the surface of the shell

c) field inside the shell

By Gauss's law $\phi = \frac{q}{\varepsilon_0} = 0$

ϕ=ES =0

$$\boxed{E = 0}$$

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Chapter 2 - Electrostatic Potential and Capacitance

1 Define electrostatic potential. Write its unit

Elecrostaic Potential at a point P in an electric field is the work done by an external force in bringing a unit positive charge from infinity to that point.

$$\boxed{V = \frac{W}{q}} \qquad W = qV$$

Unit of potential is J/C or volt (V)

2.Express electric potential as the negative gradient of electric field

$$W = -\int_{\infty}^{P} F \cdot dr = -\int_{\infty}^{P} qE \cdot dr \qquad (F = qE)$$

$$V = \frac{W}{q}$$

$$\boxed{V = -\int_{\infty}^{P} E \cdot dr}$$

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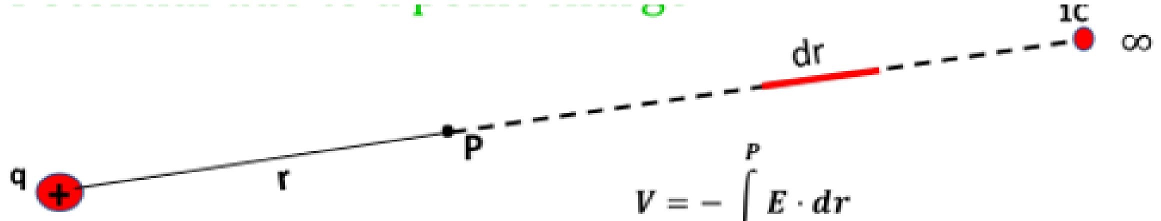
3.Obtain the equation for electric field due to a point charge.



$$V = -\int_{\infty}^{P} E \cdot dr$$

$$But\ E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

$$V = -\int_{\infty}^{P} \frac{1}{4\ \pi\varepsilon_0}\frac{q}{r^2}\ dr$$

$$V = -\frac{q}{4\pi\varepsilon_0} \times \frac{-1}{r}$$

$$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}} \qquad V \propto \frac{1}{r}$$

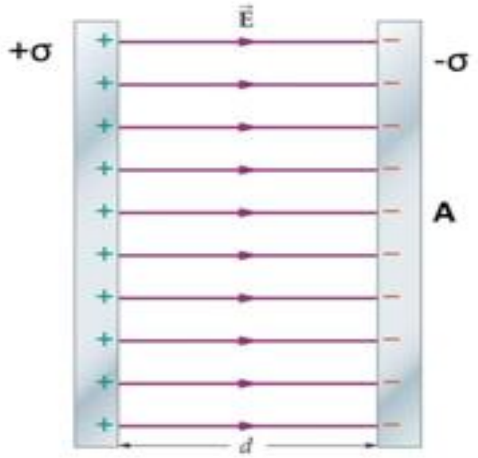
4.Define capacitance. Write its unit.

$$\boxed{C = \frac{Q}{V}}$$

The constant C is called the capacitance of the capacitor.

The SI unit of capacitance is farad (F).

5. Obtain the equation for capacitnace of a parallel plate capacitor



Capacitance, $C = \frac{Q}{V}$

$Q = \sigma A$

$V = Ed$

$E = \frac{\sigma}{\varepsilon_0}$

$$V = \frac{\sigma d}{\varepsilon_o}$$

$$C = \frac{\sigma A}{\frac{\sigma d}{\varepsilon_0}}$$

$$\boxed{C = \frac{\varepsilon_0 A}{d}}$$

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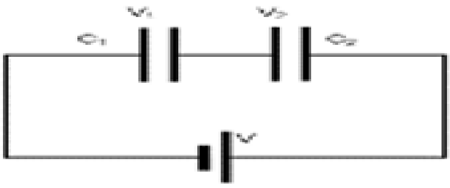
5. Obtain the equation for effective capacitance when capacitors are connected in series.



$$V = V_1 + V_2$$

$$V_1 = \frac{Q}{C_1}$$

$$V_2 = \frac{Q}{C_2}$$

$$V = \frac{Q}{C_1} + \frac{Q}{C_2} \longrightarrow (1)$$

If the two capacitors are replaced by a single capacitor of capacitance C with the same charge Q and potential difference V.

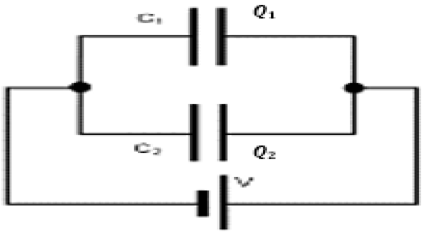
$$V = \frac{Q}{C} \longrightarrow (2)$$

Equating eq (1) &(2)

$$\frac{Q}{C} = \frac{Q}{C_1} + \frac{Q}{C_2}$$

$$\boxed{\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}}$$

5. Obtain the equation for effective capacitance when capacitors are connected in parallel.



$$Q = Q_1 + Q_2$$
$$Q_1 = C_1 V$$
$$Q_2 = C_2 V$$
$$Q = C_1 V + C_2 V \longrightarrow (1)$$

If the two capacitors are replaced by a single capacitor of capacitance C with the same charge Q and potential difference V.

$$Q = CV \longrightarrow (2)$$

From eq(1) & (2) $\quad CV = C_1 V + C_2 V$

$$\boxed{C = C_1 + C_2}$$

Obtain the expression for energy stored in a capacitor

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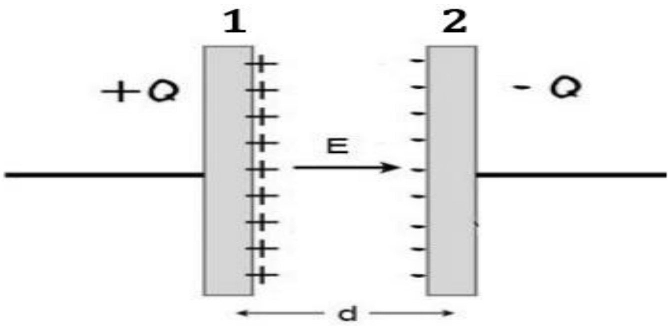

Work done to move a charge dq from conductor 2 to conductor 1

dW = Potential × Charge
dW = V dq
$dW = \frac{q}{C}\, dq$

The total work done to attain a charge Q on conductor 1, is

$$W = \int_0^Q dW = \int_0^Q \frac{q}{C} \times dq$$

$$W = \frac{Q^2}{2C}$$

This work is stored as potential energy in the electric field between the plates.

Energy $\quad U = \frac{Q^2}{2C}$

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Chapter 3- Current Electricity

1.State Ohm's law

At constant temperature ,the current flowing through a conductor is directly proportional to the potential difference between the ends of the conductor.

$$V \propto I$$

$$\boxed{V = RI}$$

$$\boxed{R = \frac{V}{I}}$$

The constant of proportionality R is called the resistance of the conductor
The SI units of resistance is ohm and is denoted by the symbol Ω

2.What are the factors on which the resistance of a conductor depends?

1) The material of the conductor

2) The dimensions of the conductor

a) Length of the conductor

b) The area of cross section of the conductor

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The resistance of a conductor is directly proportional to its length l

$$R \propto l$$

The resistance of a conductor is inversely proportional to the cross-sectional area, A.

$$R \propto \frac{1}{A}$$

3.What do you mean by resistivity of a conductor. Write its unit.

The resistance is proportional to length l of the conductor

$$R \propto l$$

The resistance R is inversely proportional to the cross-sectional area, A of the conductor.

$$R \propto \frac{1}{A}$$

Combining these Equations. $R \propto \frac{l}{A}$

$$\boxed{R = \frac{\rho l}{A}}$$

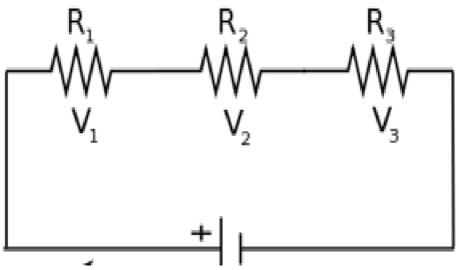
where the constant of proportionality ρ is called resistivity.

Unit of resistivity is Ωm.

4. Write Ohms law in vector form

$$\boxed{\vec{j} = \sigma\vec{E}}$$

5. Derive the equation for effective resistance when resistors are connected in series



$$V = V_1 + V_2 + V_3$$

$$V = IR_1 + IR_2 + IR_3 \text{ --------------- } (1)$$

If all the resistors are replaced with a single effective resistance R , with same potential V and current I ,

$$V = IR \text{ --------------- } (2)$$

From eq (1) and (2)

$$IR = IR_1 + IR_2 + IR_3$$

$$\boxed{R = R_1 + R_2 + R_3}$$

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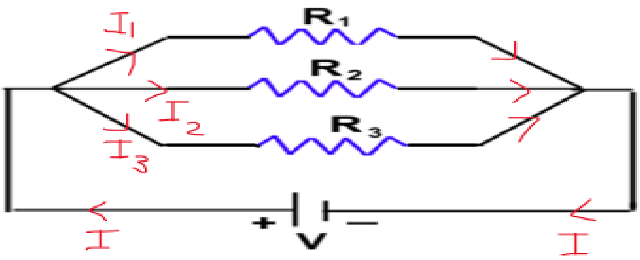
6. Derive the equation for effective resistance when resistors are connected in parallel



$$I = I_1 + I_2 + I_3$$

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} \text{ -------------(1)}$$

If three resistors are replaced by a single resistor of effective resistance R with same potential V and current I

$$I = \frac{V}{R} \text{ ---------------(2)}$$

From equations (1) and (2) $\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

$$\boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

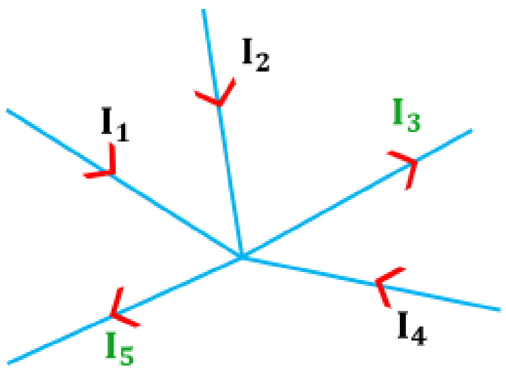
7. Write the relation connecting emf and terminal potential difference

$$\boxed{\varepsilon = V + Ir}$$

$$\boxed{V = \varepsilon - Ir}$$

8. State Kirchhoff's junction rule or current law.

At any junction, the sum of the currents entering the junction is equal to the sum of currents leaving the junction. ie., $\sum i = 0$



According to Kirchhoff's first Law

$$\boxed{I_1 + I_2 + I_4 = I_3 + I_5}$$

$$I_1 + I_2 - I_3 + I_4 - I_5 = 0$$

$$\sum i = 0$$

9. State Kirchhoff's loop rule or voltage law.

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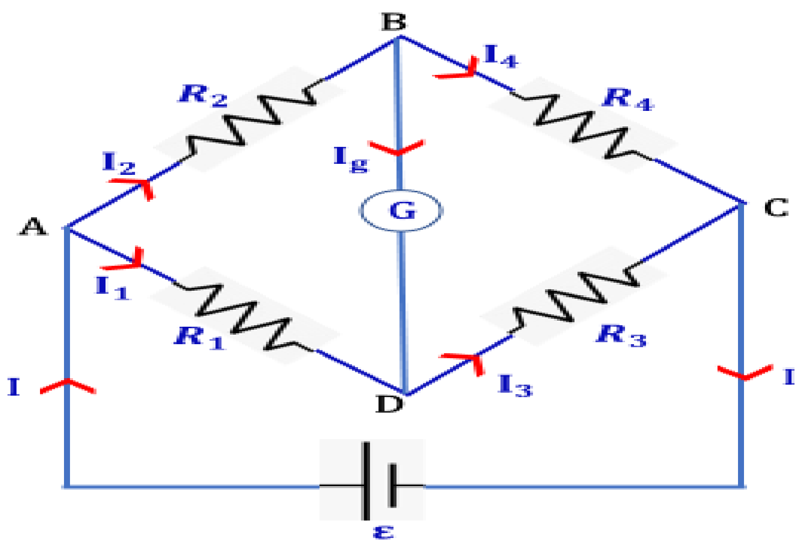
The algebraic sum of changes in potential around any closed loop is zero $\sum \Delta V = 0$

10.Obtain Wheatstone bridge principle.



For a balanced Wheatstone's bridge, the resistors are such that the current through the galvanometer $I_g = 0$.

Apply Kirchhoff's junction rule to junctions B

$$I_2 = I_4 \quad \cdots\cdots\cdots\cdots\cdots\cdots \rightarrow (1)$$

Apply Kirchhoff's junction rule to junctions D

$$I_1 = I_3 \quad \cdots\cdots\cdots\cdots\cdots\cdots \rightarrow (2)$$

Apply Kirchhoff's loop rule to closed loop ABDA

$$I_1 R_1 = I_2 R_2 \dots\dots\dots\dots\dots\rightarrow (3)$$

Apply Kirchhoff's loop rule to closed loop CBDC

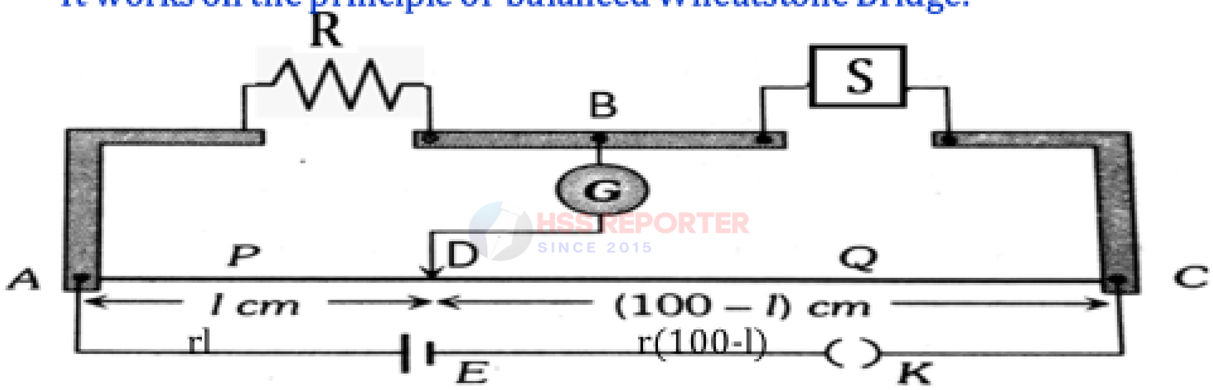
$$I_3 R_3 = I_4 R_4 \dots\dots\dots\dots\dots\rightarrow (4)$$

$$\frac{eq\ (3)}{eq\ (4)} \Longrightarrow \frac{I_1 R_1}{I_3 R_3} = \frac{I_2 R_2}{I_4 R_4} \Longrightarrow \frac{R_1}{R_3} = \frac{R_2}{R_4} \quad \text{(Using Eq 1 \& 2)}$$

$$\boxed{\frac{R_2}{R_1} = \frac{R_4}{R_3}}$$

11. How will you determine the resistance of a wire using meter bridge.

Meter Bridge is an electrical device to measure an unknown resistance.
It works on the principle of balanced Wheatstone Bridge.



By Wheatstone's principle, $\frac{R_2}{R_1} = \frac{R_4}{R_3}$

$$\frac{R}{r\,l} = \frac{S}{r(100-l)}$$

$$\boxed{R = \frac{S\,l}{(100 - l)}}$$

The resistivity of the wire $\rho = \frac{RA}{L}$

$$\boxed{\rho = \frac{R\pi r^2}{L}}$$

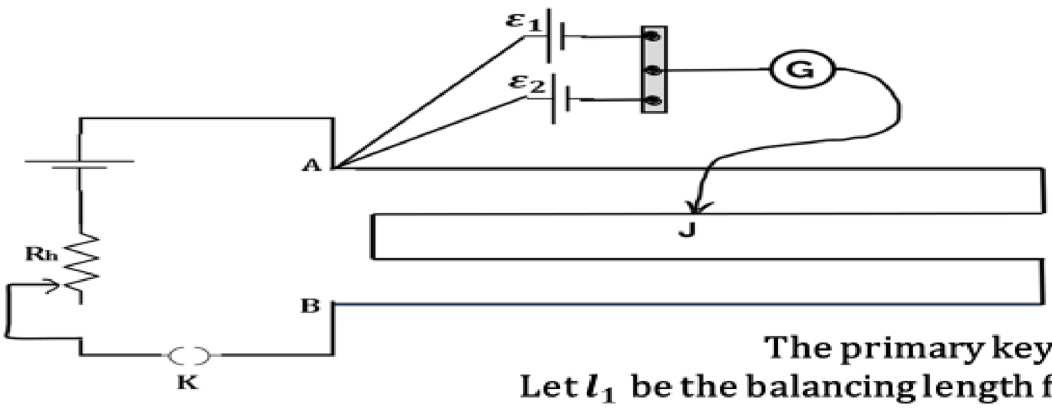
R=resistance of the wire
r=radius of the wire
L=length of the wire

12.Write the principle of potentiometer

The potential difference between two points of a current carrying conductor of uniform thickness is directly proportional to the length of the wire between the points.

$$\varepsilon \propto l$$

13. Explain the method to compare the emf's of two cells using potentiometer.



The primary key is closed.

Let l_1 be the balancing length for for cell ε_1.

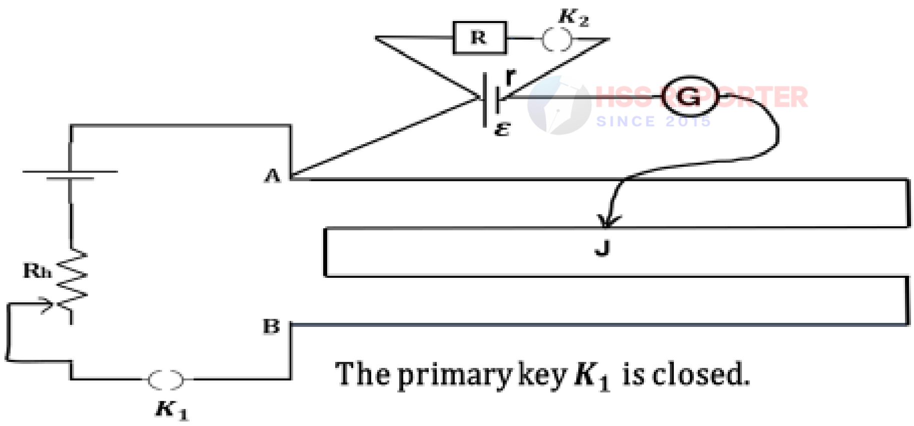
$$\varepsilon_1 \propto l_1$$

Let l_2 be the balancing length for for cell ε_2.

$$\varepsilon_2 \propto l_2$$

$$\boxed{\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}}$$

14. How will you determine the internal resistance of a cell using potentiometer?



The primary key K_1 is closed.

Now K_2 is open. Let l_1 be the balancing length

$$\varepsilon \propto l_1 \text{ --------------- (1)}$$

Now K_2 is closed. Let l_2 be the balancing length

$V \propto l_1$ $\quad$ V=IR

$$I = \frac{\varepsilon}{r+R}$$

$$V = \frac{\varepsilon R}{r+R}$$

$$\frac{\varepsilon R}{r+R} \propto l_1 \text{ --------------- (2)}$$

$$\text{eq}\frac{(1)}{(2)} \Longrightarrow \frac{\varepsilon}{\frac{\varepsilon R}{r+R}} = \frac{l_1}{l_2}$$

$$\frac{r+R}{R} = \frac{l_1}{l_2}$$

$$\frac{r}{R} + 1 = \frac{l_1}{l_2}$$

$$\frac{r}{R} = \frac{l_1}{l_2} - 1$$

$$\frac{r}{R} = \frac{l_1 - l_2}{l_2}$$

$$\boxed{r = \frac{R(l_1 - l_2)}{l_2}}$$

15. Why potentiometer is preferred over voltmeter for accurate measurement of emf of a cell?

As potentiometer uses null deflection method, it does not draw current from the cell at the balance point. Therefore, potentiometer measures the actual emf of the cell. The voltmeter always draws current from the cell and measures the terminal voltage of the cell and not the emf. So potentiometer is preferred over voltmeter for accurate measurement.

Chapter 4-Moving Charges and Magnetism

1.Write Lorentz force equation.

$$F = qE + q(v \times B)$$
$$F = q[E + (v \times B)]$$

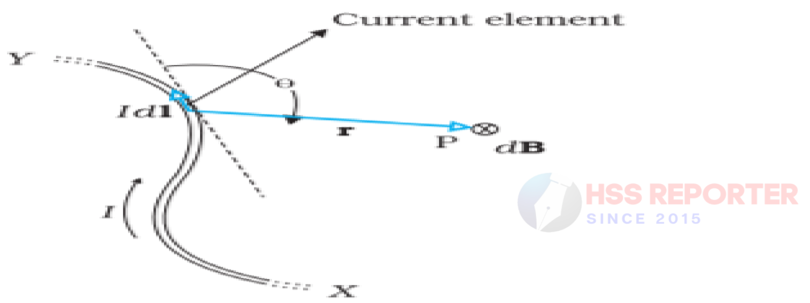
2.Write the equation for magnetic Lorentz force.

$$F = q(v \times B)$$

3. Write the expression for magnetic force on a current-carrying conductor .

$$F = I(\, l \times B\,)$$

4. State Biot-Savart Law



The magnetic field at a point due to a small element of a current carrying conductor is directly proportional to the current (I) , the length of the element dl , sine of the angle between r and dl and inversely proportional to the square of the distance r

$$dB = \frac{\mu_0}{4\pi}\frac{I\,dl\,sin\theta}{r^2}$$

5. Write the vector form of Biot-Savart Law .

$$dB = \frac{\mu_0}{4\pi}\frac{I\,\bar{dl}\times\bar{r}}{r^3}$$

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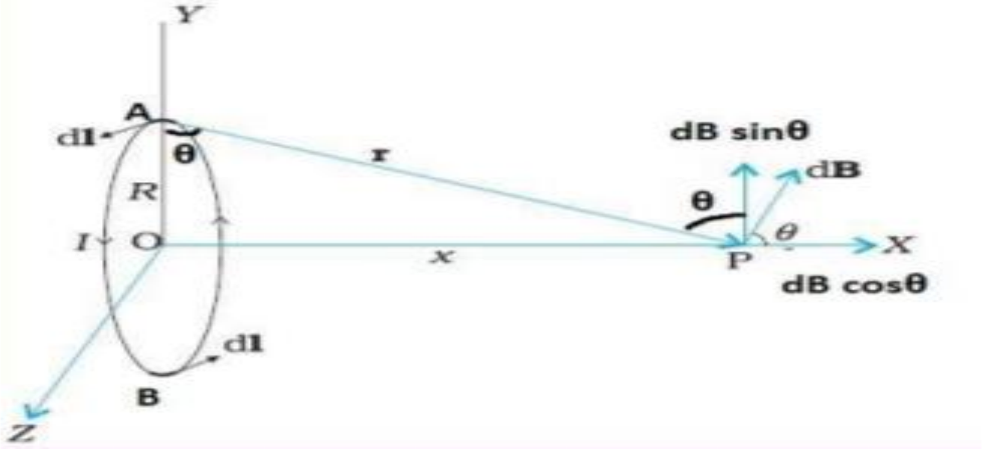
6. Using Biot-Savart Law, obtain the expression for Magnetic Field on the Axis of a Circular Current Loop.



$$dB = \frac{\mu_0}{4\pi}\frac{Idl\sin 90}{r^2}$$

$$dB = \frac{\mu_0}{4\pi}\frac{Idl}{r^2}$$

$$r^2 = x^2 + R^2$$

$$dB = \frac{\mu_0}{4\pi}\frac{Idl}{x^2+R^2}$$

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$$\cos\theta = \frac{R}{r} = \frac{R}{(x^2+R^2)^{1/2}}$$

Total field $\quad B = \int dB\cos\theta$

$$B = \int \frac{\mu_0}{4\pi}\frac{Idl}{x^2+R^2}\frac{R}{(x^2+R^2)^{1/2}}$$

$$B = \frac{\mu_0}{4\pi}\frac{IR}{(x^2+R^2)^{3/2}}\int dl$$

$$B = \frac{\mu_0}{4\pi}\frac{IR}{(x^2+R^2)^{3/2}}\, x 2\pi R$$

$$\mathbf{B = \frac{\mu_0 IR^2}{2(x^2+R^2)^{3/2}}}$$

Magnetic field at the centre of the loop

At the centre x=0

$$B = \frac{\mu_0 IR^2}{2R^3}$$

$$\mathbf{B = \frac{\mu_0 I}{2R}}$$

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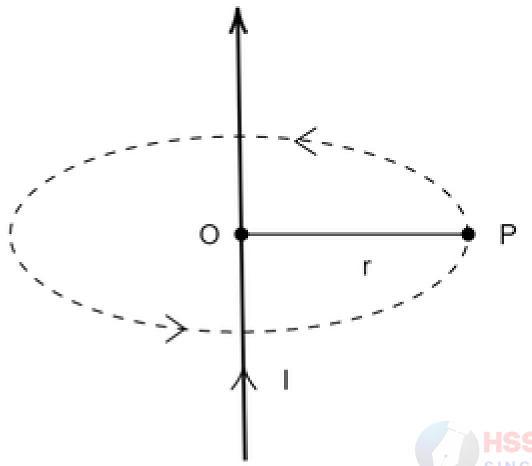
7.State Ampere's Circuital theorem.

The line integral of magnetic field over a closed loop is equal to μ_0 times the total current passing through the surface.

The closed loop is called Amperian Loop.

$$\oint \vec{B}.\vec{dl} = \mu_0 I$$

8.Using Ampere's Circuital theorem, derive the equation for Magnetic field due to a straight infinite current-carrying wire .



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By Ampere's Circuital Law

$$\oint \vec{B}.\vec{dl} = \mu_0 I$$

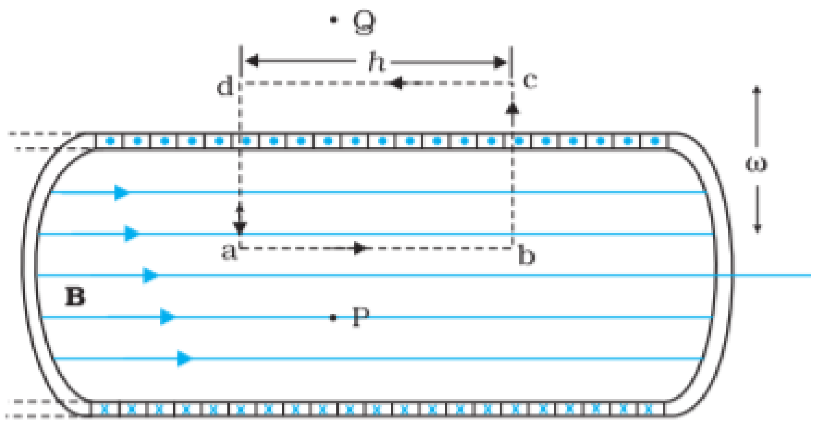
$$\oint B\,dl\cos 0 = \mu_0 I$$

$$B\oint dl = \mu_0 I$$

$$B \times 2\pi r = \mu_0 I$$

$$\mathbf{B = \frac{\mu_0 I}{2\pi r}}$$

9.Using Ampere's Circuital theorem, derive the equation for Magnetic field due to a Solenoid.



$$\oint_{abcd} \vec{B}.\vec{dl} = \oint_{ab} \vec{B}.\vec{dl} + \oint_{bc} \vec{B}.\vec{dl} + \oint_{cd} \vec{B}.\vec{dl} + \oint_{da} \vec{B}.\vec{dl} \text{ ------------(1)}$$

$$\oint_{abcd} \vec{B}.\vec{dl} = Bl + 0 + 0 + 0$$

$$\oint_{abcd} \vec{B}.\vec{dl} = Bl \text{ -------------(2)}$$

By Ampere's Circuital Law

$$\oint \mathrm{B.dl} = \mu_0 \mathrm{I}$$

For N turns of solenoid

$$\oint \mathrm{B.dl} = \mu_0 \mathrm{NI} \text{ ---------------(3)}$$

From eqns (2) and (3)

$$Bl = \mu_0 \mathrm{NI}$$

$$B = \frac{\mu_0 \mathrm{NI}}{l}$$

$$\boldsymbol{B = \mu_0 nI} \qquad \textbf{where } n = \frac{N}{l}$$

N=number of turns of solenoid

L= length of solenoid

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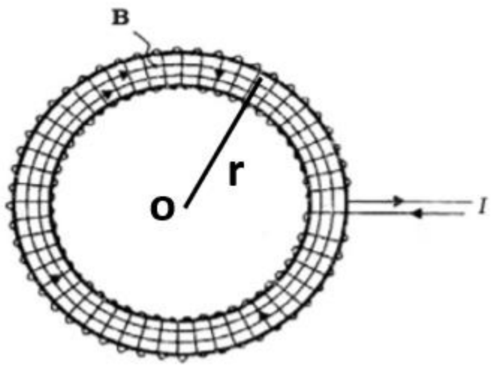
10.Using Ampere's Circuital theorem, derive the equation for Magnetic field due to a Toroid.



By Ampere's Circuital Law

$$\oint \vec{B}.\vec{dl} = \mu_0 \mathrm{I}$$

For N turns

$$\oint \vec{B}.\vec{dl} = \mu_0 \mathrm{NI}$$

$$\oint \mathrm{B\,dl} \cos 0 = \mu_0 \mathrm{NI}$$

$$\mathrm{B} \oint \mathrm{dl} = \mu_0 \mathrm{NI}$$

$$\mathrm{B} \times 2\pi \mathrm{r} = \mu_0 \mathrm{NI}$$

$$\mathrm{B} = \frac{\mu_0 \mathrm{NI}}{2\pi \mathrm{r}}$$

$$\mathbf{B = \mu_0 nI} \qquad \textbf{where } \mathbf{n} = \frac{\mathbf{N}}{\mathbf{2\pi r}}$$

Chapter 5- Magnetism and Matter

1. State Gauss's Law in magnetism.

Gauss's law for magnetism states that the net magnetic flux through any closed surface is zero.

$$\boldsymbol{\phi = \oint \vec{B} \cdot d\vec{s} = 0}$$

2. Explain Dynamo effect.

Earth's magnetic field arise due to electrical currents produced by convective motion of metallic fluids (consisting mostly of molten iron and nickel) in the outer core of the earth. This is known as the dynamo effect.

3. What is Geographic meridian

Geographic meridian at a place is the vertical plane passing through the place and the geographic poles.

4.What is magnetic meridian

The magnetic meridian of a place is the vertical plane passing through the the magnetic north and the south poles.

5. What are the elements of the earth's magnetic field.

1. Magnetic Declination(D)
2. Magnetic Dip or Inclination (I)
3. The horizontal component, (H_E)

6. Define magnetic Declination (D)

Declination at a place is the angle between geographic meridian and magnetic meridian at that place.

7. Define Dip or Inclination (I)

Dip or inclination is the angle that the total intensity of earth's magneti field(B_E) at the place makes with the horizontal(H_E).

8.Define Horizontal Intensity (H_E)

Horizontal Intensity at a place is the horizontal component of the total Intensity of Earth's magnetic field at the place.

9.Write the values of dip at poles and equator?

The value of dip is 90^0 at magnetic poles.

The value of dip is 0^0 at magnetic equator.

10. Show that $B_E = \sqrt{H_E^2 + Z_E^2}$

$$\mathbf{H_E = B_E \cos I} \text{-------}(1)$$

$$\mathbf{Z_E = B_E \sin I} \text{-------}(2)$$

$$\frac{eq(1)}{eq(2)} \text{........} \tan I = \frac{Z_E}{H_E}$$

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$$\sqrt{H_E^2 + Z_E^2} = \sqrt{B_E^2 \cos^2 I + B_E^2 \sin^2 I}$$

$$= \sqrt{B_E^2 (\cos^2 I + \sin^2 I)}$$

$$= \sqrt{B_E^2} = B_E$$

$$\mathbf{B_E = \sqrt{H_E^2 + Z_E^2}}$$

11.Problem

Example 5.9 In the magnetic meridian of a certain place, the horizontal component of the earth's magnetic field is 0.26G and the dip angle is 60°. What is the magnetic field of the earth at this location?

Solution

It is given that H_E = 0.26 G. From Fig. 5.11, we have

$$\cos 60^0 = \frac{H_E}{B_E}$$

$$B_E = \frac{H_E}{\cos 60^0}$$

$$= \frac{0.26}{(1/2)} = 0.52 \text{ G}$$

12. Define Magnetisation(M).

The net magnetic dipole moment developed per unit volume of a material is called Magnetisation(M).

$$\boldsymbol{M} = \frac{\boldsymbol{m_{net}}}{\boldsymbol{V}}$$

13.Define Magnetic intensity or Magnetising field(H)

The field which induces magnetism in a magnetic substance is called magnetising field(H)

$$\boldsymbol{H} = \frac{\boldsymbol{B}}{\mu}$$

14. Define Magnetic Susceptibility

The Magnetisation, M of material is proportional to the magnetising field.

$$\chi = \frac{\boldsymbol{M}}{\boldsymbol{H}}$$

15. Obtain the relation connecting relative permeability and magnetic susceptibility.

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Consider a long solenoid of n turns per unit length and carrying a current I.

$$B = B_0 + B_m$$

$$B_0 = \mu_0 nI$$

$$B_m = \mu_0 M$$

$$B = \mu_0 nI + \mu_0 M$$

nI=H, the magnetising field

$$B = \mu_0 H + \mu_0 M$$

$$B = \mu_0 (H + M)$$

$$M = \chi H$$

$$B = \mu_0 (H + \chi H)$$

$$B = \mu_0 (1 + \chi)H) \text{ ---------------(1)}$$

$$B = \mu_0 \mu_r H \quad \text{-----------------(2)}$$

From (1) and (2)

$$\boldsymbol{\mu_r = 1 + \chi}$$

μ_r is a dimensionless quantity called the relative magnetic permeability of the substance.

Chapter 6- Electromagnetic Induction

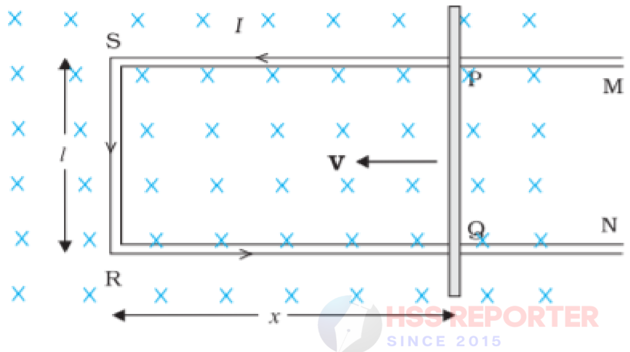
1.State Faraday's Law of Induction

Faraday's Law of Electromagnetic induction states that the magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit.

$$\varepsilon = \frac{-d\phi}{dt}$$

2.Obtain the expression for motional emf

When a conducting rod is moved through a constant magnetic field, an emf is developed between the ends of the rod. This emf is known as motional emf.



$$\phi = Blx$$

$$\varepsilon = \frac{-d\Phi_B}{dt} = -\frac{d}{dt}(Blx)$$

$$\varepsilon = -Bl\frac{dx}{dt}$$

$$v = \frac{-dx}{dt} \textit{ is the speed of the conductor}$$

$$\varepsilon = Blv$$

The induced emf Blv is called motional emf.

3.What are Eddy Currents?

When bulk pieces of conductors are subjected to changing magnetic flux, induced currents are produced in them. These currents are called eddy currents. This effect was discovered by physicist Foucault.

4 Write any four advantages of Eddy currents

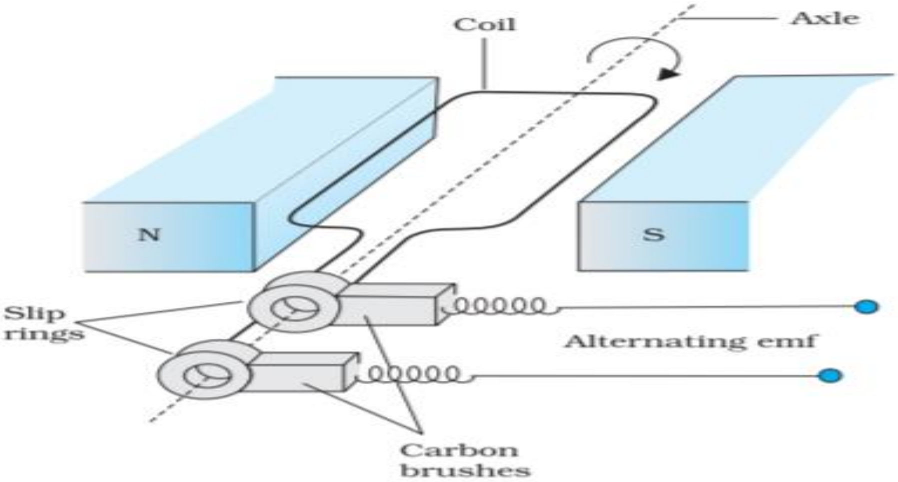
Magnetic breaking in Trains

Electromagnetic Damping

Induction Furnace

Electric power meters

5.Obtain the expression for ac voltage produced in an ac generator.



The magnetic flux at any time t is

$$\phi = BA\cos\theta = BA\cos\omega t$$

From Faraday's law, the induced emf for the rotating coil of N turns is

$$\varepsilon = -N\frac{d\phi}{dt}$$

$$\varepsilon = -N\frac{d}{dt}BA\cos\omega t$$

$$\varepsilon = -NBA\frac{d}{dt}\cos\omega t$$

$$\varepsilon = NBA\omega\sin\omega t$$

$$\varepsilon = \varepsilon_0\sin\omega t$$

where $\varepsilon_0 = NBA\omega$ is the maximum value of the emf.

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Chapter 7-Alternating Current

1.Write the expression for rms current

$$I_{rms} = \frac{i_m}{\sqrt{2}} = 0.707\ i_m$$

2.Write the expression for rms voltage

$$V_{rms} = \frac{v_m}{\sqrt{2}} = 0.707\ v_m$$

3.Write the equation for inductive reactance

$$X_L = \omega L = 2\pi f L$$

4.Write the equation for capacitive reactance

$$X_C = \frac{1}{\omega C}$$

$$X_C = \frac{1}{2\pi f C}$$

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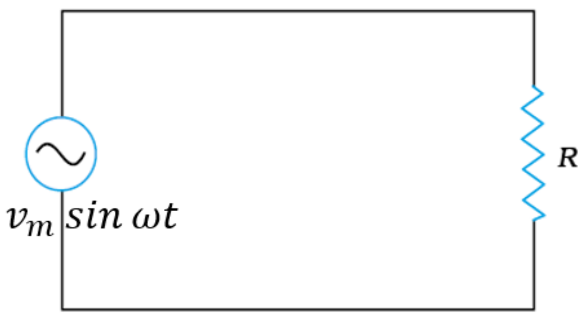
5.Obtain the expression for current when ac voltage is applied to a resistor



Apply Kirchhoff's Loop rule ,$\Sigma\varepsilon(t) = 0$

$v_m \sin \omega t - i\,R = 0$

$v_m \sin \omega t = iR$

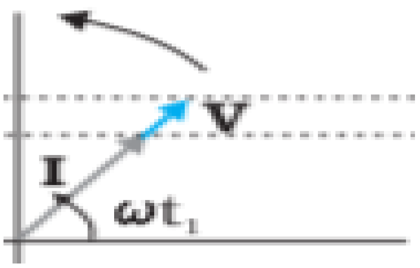
$$i = \frac{v_m \sin \omega t}{R}$$

$$i = \frac{v_m}{R} \sin \omega t$$

$$i = i_m \sin \omega t$$

where $i_m = \frac{v_m}{R}$

6.Draw the phasor diagram for voltage and current when ac voltage is applied to a resistor.



7.Obtain the expression for current when ac voltage is applied to an inductor

Apply Kirchhoff's Loop rule ,$\Sigma\varepsilon(t) = 0$

$$v_m \sin \omega t - L\frac{di}{dt} = 0$$

$$v_m \sin \omega t = L\frac{di}{dt}$$

$$\frac{di}{dt} = \frac{v_m \sin \omega t}{L}$$

$$di = \frac{v_m}{L} \sin \omega t$$

$$i = \int \frac{v_m}{L} \sin \omega t \, dt$$

$$i = \frac{v_m}{L} x \frac{-\cos \omega t}{\omega}$$

$$i = -\frac{v_m}{\omega L} \cos \omega t$$

$$i = -i_m \cos \omega t$$

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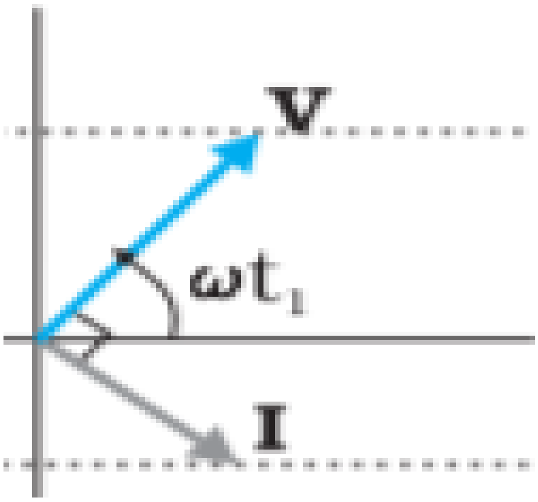
$$-\cos \omega t = \sin\left(\omega t - \frac{\pi}{2}\right)$$

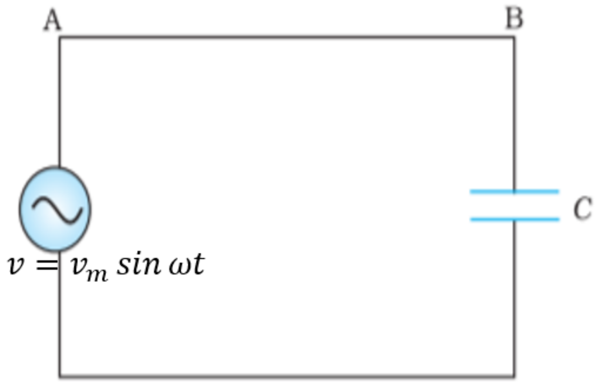
$$i = i_m \sin\left(\omega t - \frac{\pi}{2}\right)$$

$$where\ i_m = \frac{v_m}{\omega L}$$

8.Draw the phasor diagram for voltage and current when ac voltage is applied to an inductor.



9.Obtain the expression for current when ac voltage is applied to a capacitor



Apply Kirchhoff's Loop rule ,$\Sigma\varepsilon(t) = 0$

$$v_m \sin \omega t - \frac{q}{C} = 0$$

$$v_m \sin \omega t = \frac{q}{C}$$

$$q = C\, v_m \sin \omega t$$

$$i = \frac{dq}{dt}$$

$$i = \frac{d}{dt}(C\, v_m \sin \omega t)$$

$$i = C\, v_m \frac{d}{dt}(\sin \omega t)$$

$$i = C\, v_m\, \omega \cos \omega t$$

$$i = \omega C\, v_m \cos \omega t$$

$$\mathbf{i = i_m \cos \omega t}$$

$$\cos \omega t = \sin\left(\omega t + \frac{\pi}{2}\right)$$

$$\mathbf{i = i_m \sin\left(\omega t + \frac{\pi}{2}\right)} \quad \text{where } i_m = \omega C\, v_m$$

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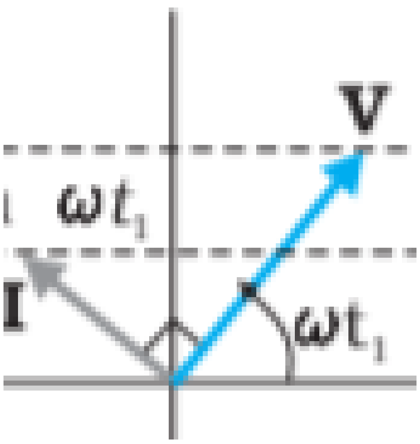
10.Draw the phasor diagram for voltage and current when ac voltage is applied to a capacitor.



11.What is the principle of working of a transformer.

Mutual induction

12. What is a step up transformer

For a step up transformer the number of turns in the secondary will be greater than that in the primary($N_S > N_P$)

$$V_s = \left(\frac{N_S}{N_P}\right) V_p \qquad I_s = \left(\frac{N_P}{N_S}\right) V_p$$

$$\left(\frac{N_S}{N_P}\right) > 1 \qquad \left(\frac{N_P}{N_S}\right) < 1$$

$$V_s > V_p \qquad I_s < I_p$$

13.What is a step down transformer

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For a step down transformer the number of turns in the secondary will be less than that in the primary($N_S < N_P$)

$$V_s = \left(\frac{N_S}{N_P}\right) V_p \qquad I_s = \left(\frac{N_P}{N_S}\right) V_p$$

$$\left(\frac{N_S}{N_P}\right) < 1 \qquad \left(\frac{N_P}{N_S}\right) > 1$$

$$V_s < V_p \qquad I_s > I_p$$

14.Write different energy losses in a tranformer

(i) Flux Leakage:
(ii) Resistance of the windings :
(iii) Eddy currents loss:
(iv) Hysteresis loss:

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Chapter 8-Electromagnetic Waves

1.What is Displacement Current?

The current due to changing electric field or electric flux is called called displacement current or Maxwell's displacement current.

$$i_d = \varepsilon_0 \frac{d\phi_E}{dt}$$

2.Write Ampere-Maxwell law (or) Maxwell's mlodification to Ampere's circuital theorem.

$$\oint B \cdot dl = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$$

3.List the properties of electromagnetic waves (any four)

1) In an e.m waves are transverse waves in which the electric and magnetic fields are perpendicular to each other, and also to the direction of propagation.

2) The speed of e.m.wave in vacuum is,

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

3)The speed of of electromagnetic waves in a material medium is

$$c = \frac{1}{\sqrt{\mu \varepsilon}}$$

4) The electric and the magnetic fields in an electromagnetic wave are related as

$$\frac{E_0}{B_0} = c$$

5) No material medium is required for the propagation of e.m.wave.

6) Electromagnetic waves carry energy as they travel through space and this energy is shared equally by the electric and magnetic fields.

7)Electromagnetic waves transport momentum as well. When these waves strike a surface, total momentum delivered to this surface is,

$$p = \frac{U}{c}$$ where U is the energy

Chapter 9- Ray Optics and Optical Instruments

1.Write the laws of reflection

1)The angle of incidence is equai to the angle of reflection.

2)The incident ray, reflected ray and the normal to the reflecting surface at the point of incidence lie in the same plane.

2.Write the Cartesian sign convention to measure distances.

1) All distances are measured from the pole of the mirror or the optical centre of the lens.
2) The distances measured in the same direction as the incident light are taken as positive and those measured in the direction opposite to the direction of incident light are taken as negative.
3) The heights measured upwards with respect to principal axis of the mirror/ lens are taken as positive .The heights measured downwards are taken as negative.

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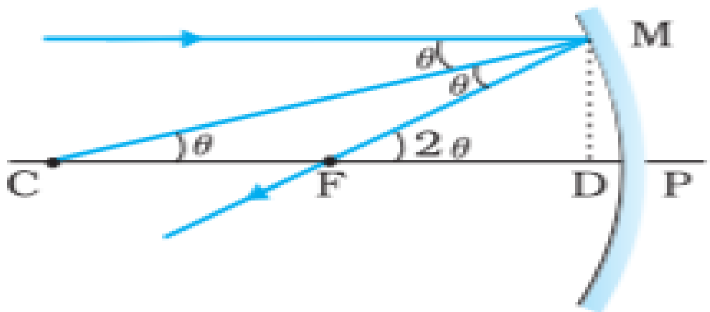
3.Obtain the relation between Focal Length and Radius of Curvature



From figure $\tan\theta = \frac{MD}{CD}$ and $\tan 2\theta = \frac{MD}{FD}$

For small value of θ, tanθ ≈ θ, tan 2θ ≈ 2θ.

$$\theta = \frac{\text{MD}}{\text{CD}}$$

$$2\theta = \frac{\text{MD}}{\text{FD}}$$

Substituting the value of θ

$$2\frac{\text{MD}}{\text{CD}} = \frac{\text{MD}}{\text{FD}}$$

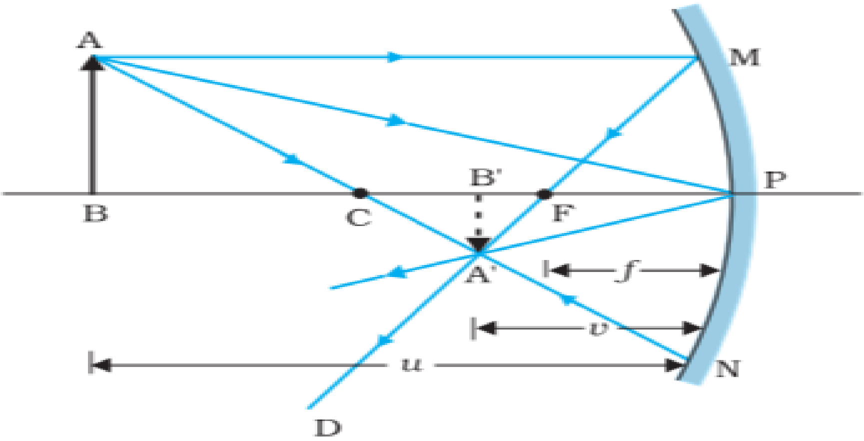
$$FD = \frac{CD}{2}$$

$$FD = f = \text{Focal length}$$

$$CD = R = \text{Radius of curvature}$$

$$\mathbf{f = \frac{R}{2}}$$

4.Obtain the mirror equation



The two right-angled triangles A′B′F and MPF are similar

$$\frac{B'A'}{PM} = \frac{B'F}{FP}$$

$$\frac{B'A'}{BA} = \frac{B'F}{FP} \text{------------}(1) \quad (\text{since } PM = AB)$$

The right angled triangles A′B′P and ABP are also similar.

$$\frac{B'A'}{BA} = \frac{B'P}{BP} \text{------------}(2)$$

From eqns(1) and (2)

$$\frac{B'F}{FP} = \frac{B'P}{BP} \qquad (\mathbf{B'F = B'P - FP})$$

$$\frac{B'P - FP}{FP} = \frac{B'P}{BP}$$

$$\mathbf{B'P = -v, FP = -f, BP = -u}$$

$$\frac{-v - -f}{-f} = \frac{-v}{-u}$$

$$\frac{v-f}{f} = \frac{v}{u}$$

$$\frac{v}{f} - 1 = \frac{v}{u}$$

Dividing by v

$$\frac{1}{f} - \frac{1}{v} = \frac{1}{u}$$

$$\mathbf{\frac{1}{u} + \frac{1}{v} = \frac{1}{f}}$$

This relation is known as the mirror equation.

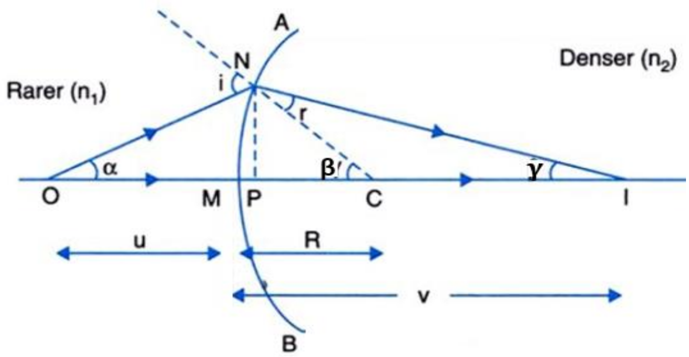
5.State the laws of refraction

(i) The incident ray, the refracted ray and the normal to the interface at the point of incidence, all lie in the same plane.

(ii) The ratio of the sine of the angle of incidence to the sine of angle of refraction is constant

$$\frac{\sin i}{\sin r} = n_{21}$$

6.Obtain the relation between object and image distance in terms of refractive index of the medium and the radius of curvatures when refraction occurs through a spherical surface.



$$\tan \alpha = \frac{MN}{OM}$$

$$\tan \beta = \frac{MN}{MC}$$

$$\tan \gamma = \frac{MN}{MI}$$

For small values of α , β and γ

$$\alpha = \frac{MN}{OM}$$

$$\beta = \frac{MN}{MC}$$

$$\gamma = \frac{MN}{MI}$$

From ΔNOC, $\quad i = \alpha + \beta$--------------(1)

From ΔNIC, $\quad \beta = r + \gamma$

$$r = \beta - \gamma \text{---------------(2)}$$

From Snell's law

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$$

$$n_1 \sin i = n_2 \sin r$$

For small values of i and r

$$n_1\, i = n_2 r$$

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Substituting fron eqn (1) and (2)

$$n_1\,(\alpha + \beta) = n_2\,(\beta - \gamma)$$

$$n_1\left(\frac{MN}{OM} + \frac{MN}{MC}\right) = n_2\left(\frac{MN}{MC} - \frac{MN}{MI}\right)$$

$$\frac{n_1}{OM} + \frac{n_1}{MC} = \frac{n_2}{MC} - \frac{n_2}{MI}$$

$$\frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2}{MC} - \frac{n_1}{MC}$$

$$\frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$$

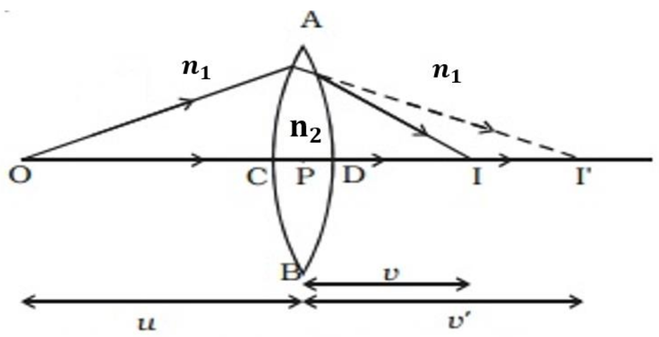
Applying the Cartesian sign convention,

OM = –u, MI = +v, MC = +R

$$\frac{n_1}{-u} + \frac{n_2}{v} = \frac{n_2 - n_1}{R}$$

$$\boldsymbol{\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}}$$

7.Derive Lens maker's formula



For the first interface ACB of radius of curvature R_1

$$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1} \text{ ----------(1)}$$

For the first interface ADB of radius of curvature R_2

$$\frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_1 - n_2}{R_2} \text{ -------------(2)}$$

Eqns (1) + (2)

$$\frac{n_2}{v'} - \frac{n_1}{u} + \frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_2 - n_1}{R_1} + \frac{n_1 - n_2}{R_2}$$

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$$\frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Dividing throughout by n_1

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{v} - \frac{1}{u} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \text{------------(3)}$$

When u=∞ (infinity) , v=f

$$\frac{1}{f} - \frac{1}{\infty} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

If the lens is placed in air

$$\mathbf{\frac{1}{f} = (n - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \text{-----------(4)}}$$

This Equation is known as the lens maker's formula.

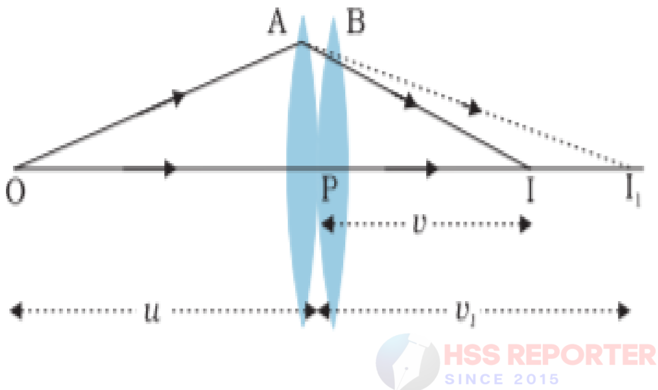
8. Define Power of a lens. Write its unit

Power of a lens is the reciprocal of focal length expressed in metre

$$p = \frac{1}{f}$$

The SI unit for power of a lens is dioptre D.

9.Obtain the expression for effective focal length when two thin lenses are kept in contact



For the image formed by the first lens A,

$$\frac{1}{v_1} - \frac{1}{u} = \frac{1}{f_1} \text{ -----------(1)}$$

For the image formed by the second lens B,

$$\frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_2} \text{ -----------(2)}$$

Eqn (1) +(2)

$$\frac{1}{v_1} - \frac{1}{u} + \frac{1}{v} - \frac{1}{v_1} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_1} + \frac{1}{f_2} \text{ -----------(3)}$$

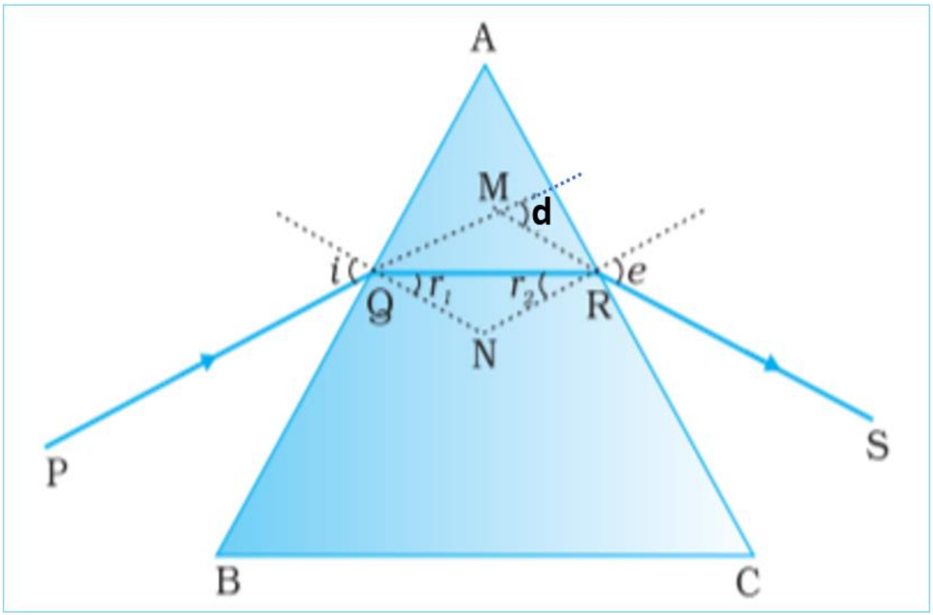
If the two lens-system is regarded as equivalent to a single lens of focal length f, we have

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \text{ ---------------(4)}$$

From eqn (3) and (4)

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

10.Draw the path of the ray which is refracted through a prism and obtain the equation for refractive index of material of prism. Draw the i-d curve



In the quadrilateral AQNR,

$$\angle A + \angle QNR = 180^{\circ}$$

From the triangle QNR,

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$$r_1 + r_2 + \angle QNR = 180^{\circ}$$

Comparing these two equations, we get

$$r_1 + r_2 = A \text{ ------------------(1)}$$

The total deviation δ is the sum of deviations at the two faces,

$$d = (i - r_1) + (e - r_2)$$

$$d = i + e - (r_1 + r_2)$$

$$d = i + e - A \text{ -----------------(2)}$$

Thus, the angle of deviation depends on the angle of incidence

At the minimum deviation

$$d = D, \quad i = e, \quad r_1 = r_2 = r$$

From eqn (1)

$$2r = A$$

$$R = \frac{A}{2} \text{ ----------------(3)}$$

From eqn (2)

$$d = 2i - A$$

$$2i = A + D$$

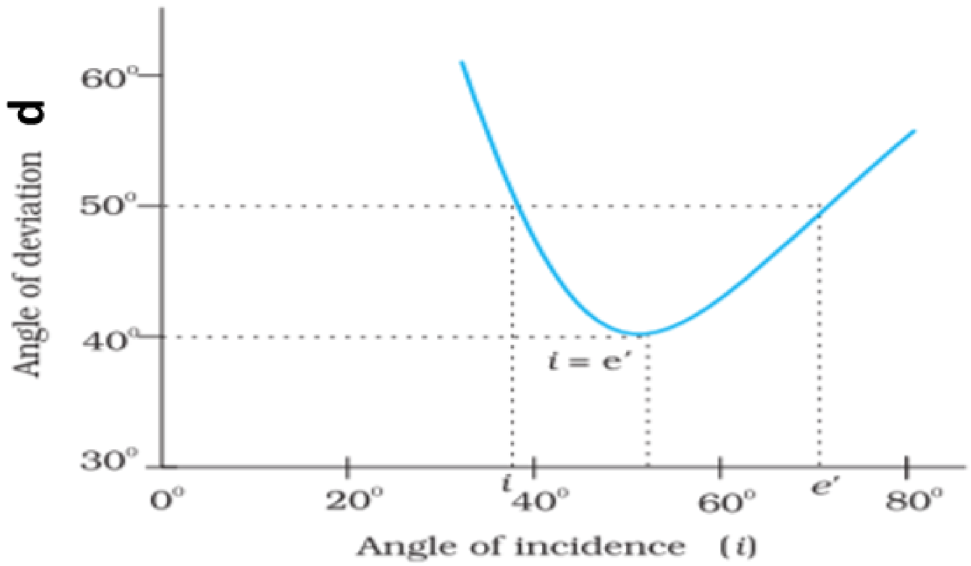
$$i = \frac{A + D}{2} \text{ -------------(4)}$$

By Snell's law the refractive index of prism

$$n = \frac{\sin i}{\sin r}$$

$$n = \frac{\sin \frac{A + D}{2}}{\sin \frac{A}{2}}$$

Graph between the angle of deviation and angle of incidence - i-d curve



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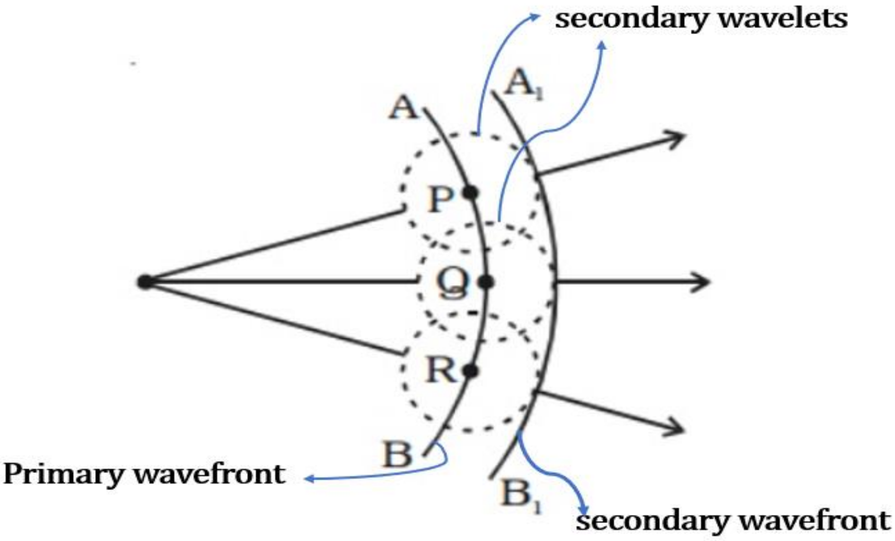
Chapter 10-Wave Optics

1.Explain Huygens Principle

According to Huygens principle, each point of the wavefront acts as a source secondary wavelets and if we draw a common tangent to all these secondary wavelets, we obtain the new position of the wavefront at a later time.



2.Explain the law of refraction based on Huygens Principle

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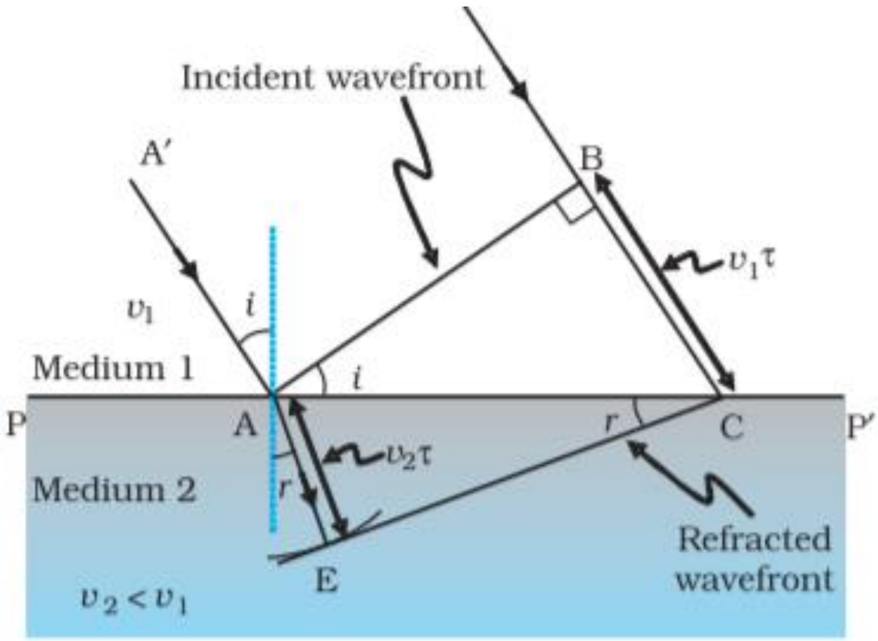


AB is the incident wavefront and EC is the refracted wavefront.

v_1 be the velocity in medium 1, then BC $= v_1\tau$

$$\sin i = \frac{BC}{AC} = \frac{v_1\tau}{AC} \text{ ----------(1)}$$

v_2 be the velocity in medium 2, then AE $= v_2\tau$

$$\sin r = \frac{AE}{AC} = \frac{v_2\tau}{AC} \text{ ----------(2)}$$

$$\text{eqn}\frac{(1)}{(2)} \qquad \frac{\sin i}{\sin r} = \frac{v_1}{v_2} \text{ --------------(3)}$$

Refractive index of first medium $\quad n_1 = \frac{c}{v_1}$

Refractive index of second medium $\quad n_2 = \frac{c}{v_2}$

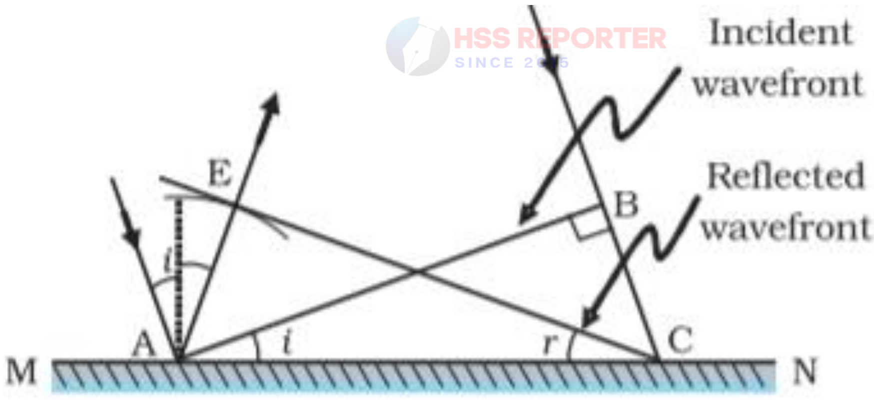
$$\frac{n_2}{n_1} = \frac{v_1}{v_2}$$

Substituting in eqn (3)

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$$

This is the Snell's law of refraction.

3.Explain the law of reflection based on Huygens Principle.



AB is the incident wavefront and EC is the reflected wavefront.

Let v be the velocity of the wave ,then

$$AE = BC = v\tau$$

$$AC = AC \text{ (common side)}$$

So the triangles EAC and BAC are congruent . Therefore

$$\mathbf{i = r}$$

Angle of incidence=Angle of reflection

This is the law of reflection.

4. State Malus' Law

When an unpolarised light is passed through two polaroids P_1 and P_2 and if the angle between the polaroids is varied from 0º to 90º, the intensity of the transmitted light will vary as:

$$I = I_0 \cos^2\theta$$

Where I_0 is the intensity of the polarized light after passing through P_1.

5.State Brewster's law

Brewster's law states that the tangent of the Brewster's angle is equal to the refractive index of the medium.

$$n = \tan i_B$$

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Chapter 11- Dual Nature of Radiation and Matter

1.What is photoelectric Effect

The phenomenon of emission of electrons when photosensitive substances are illuminated by light of suitable frequency is called photoelectric effect.

2.Obtain Einstein's Photoelectric Equation

When a photon incident on a metal surface ,a part of its energy is used as work function and the remaining part is used to give kinetic energy to emitted photoelectrons.

Energy of photon =work function + KE of electrons

$$hv = \phi_0 + \frac{1}{2}mv^2 \text{ ---------------------------- } (1)$$

When $v = v_0$,KE = 0

$$hv_0 = \phi_0$$

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Substituting in equation (1) ,

$$hv = hv_0 + \frac{1}{2}mv^2$$

$$\boldsymbol{hv - hv_0 = \frac{1}{2}mv^2}$$

3. Define work function

The minimum energy required by an electron to escape from a metal surface is called work function

$$\phi_0 = hv_0$$

It is expressed in electron volt(eV)

4.Define threshold frequency

The minimum frequency of incident radiation below which photo electric emission is not possible is called threshold frequency.

5. Write the properties of photon

or

Explain particle nature of light –The Photon (Any four)

1) In the interaction of light with matter , light behaves as if it is made up of particles called photon.

2) Each photon has energy, E=hν and momentum p= hν/c and speed c= 3x 10^8m/s

3) All photons of light of a particular frequency ν, or wavelength λ, have the same energy and momentum p, whatever the intensity of radiation may be.

4) When intensity of light is increased only the number of photons increases, but the energy of photon is independent of intensity of light.

5) Photons are electrically neutral. They are not deflected by electric and magnetic fields.

6) In photon-particle collision total energy and total momentum are conserved. However, the number of photons may not be conserved in a collision. The photon may be absorbed or a new photon may be created.

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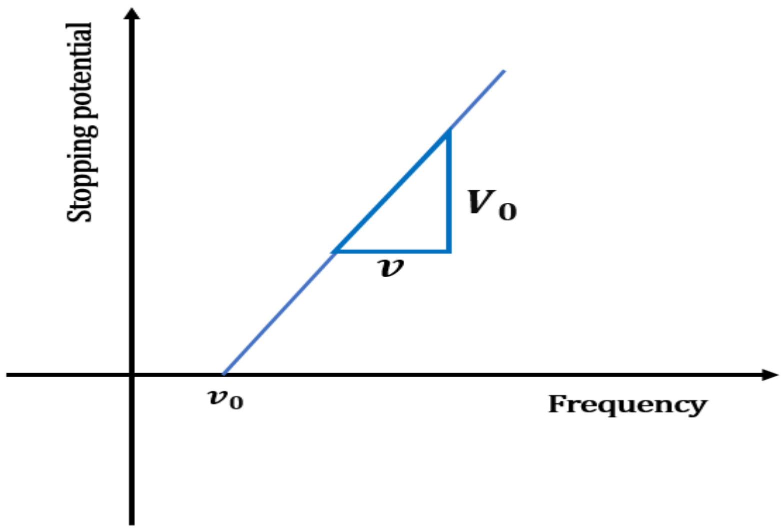
6.Draw the graphical variation of stopping potential V_0 and frequency ν. What is the slope of this graph?



slope of graph, $\frac{V_0}{\nu} = \frac{h}{e}$

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Chapter 12- Atoms

1.Write the posyulates of Bohr atom model.

1) Bohr's first postulate states that an electron in an atom revolves in certain stable orbits without the emission of radiant energy.

2) Second postulate states that the electron revolves around the nucleus only in those orbits for which the angular momentum is an integral multiple of h/2π where h is the Planck's constant

$$L = mvr = \frac{nh}{2\pi} \quad \text{,where } n = 1,2,3.........$$

n is called principal quantum number

3) Third postulate states that when an electron make a transition from higher energy level to lower energy level a photon is emitted having energy equal to the energy difference between the initial and final states. The frequency of the emitted photon is then given by

$$h\nu = E_i - E_f$$

2. Write the expression for radius of Hydrogen atom.

$$\mathbf{r_n = \frac{n^2h^2\varepsilon_0}{\pi me^2}} \qquad \text{or} \qquad \mathbf{r_n} = 0.53\ \mathbf{n^2} Å$$

3.Write the expression for energy of Hydrogen atom

$$\mathbf{E_n = \frac{-me^4}{8n^2{\varepsilon_0}^2h^2}} \qquad \text{or} \qquad \mathbf{E_n = \frac{-13.6}{n^2}\ eV}$$

4. Define Ionisation Energy

The minimum energy required to free the electron from the ground state of the atom is called the Ionisation energy.

5 Write the Ionisation energy of Hydrogen atom.

Ionisation energy of Hydrogen atom is +13.6 eV

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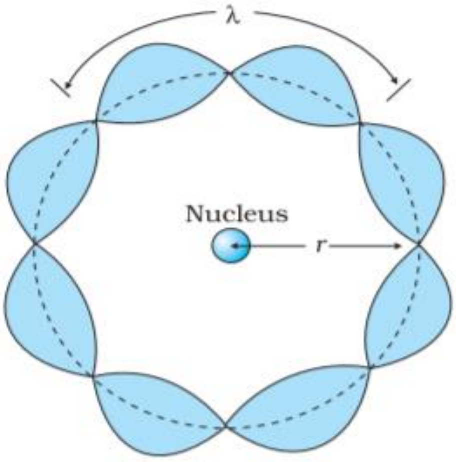
6.Explain how de Broglie Explaned Bohr's second postulate of Quantisation.

De Broglie argued that electron in its circular orbit behaves as a particle wave. The particle wave can produce standing wave under resonant condition.



For $\boldsymbol{n^{th}}$ orbit of radius r_n , the resonant condition is

$$2\,\pi\, r_n = n\,\lambda \text{-------------}(1)$$

Where n=1,2,3.....

But by de Broglie hypothesis , for matter waves

$$\boldsymbol{\lambda = \frac{h}{mv}} \text{---------------}(2)$$

Substituing eqn (2) in eqn (1),

$$2\,\pi\, r_n = n\,\frac{\mathbf{h}}{\mathbf{mv}}$$

$$\mathbf{mv\, r_n = \frac{nh}{2\,\pi}} \qquad \textbf{where n=1,2,3......}$$

This Bohr's second postulate of Quantisation.

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Chapter 13- Nuclei

1.State the Law of radioactive decay

This law states that the number of nuclei undergoing the decay per unit time is proportional to the total number of nuclei in the sample.

$$\frac{dN}{dt} = -\lambda N$$

2. Obtain the expression for number of radioactive nuclei at time t.

$$\frac{dN}{dt} = -\lambda N$$

$$\frac{dN}{N} = -\lambda dt$$

Now, integrating both sides of the above equation,we get,

$$\int \frac{dN}{dt} = -\lambda \int dt$$

$$\ln N - \ln N_0 = -\lambda (t - t_0)$$

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Here N_0 is the number of radioactive nuclei in the sample at time t 0 and N is the number of radioactive nuclei at any subsequent time t. Setting $t_0 = 0$

$$\ln \frac{N}{N_0} = -\lambda t$$

Taking exponential on both sides

$$\frac{N}{N_0} = e^{-\lambda t}$$

$$\mathbf{N = N_0 e^{-\lambda t}}$$

3.Define Half-life of a radioactive nuclei

Half-life is the time at which the number of radioactive nuclei reduce to half of their initial value.

$$\boldsymbol{T_{1/2} = \frac{0.693}{\lambda}}$$

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3.Define Mean life of a radioactive nuclei

mean life τ, is the time at which the number of radioactive nuclei reduces to e^{-1} of their initial value.

$$\tau = \frac{1}{\lambda}$$

4.Write the relation connecting Half life and Mean life of a radioactive nuclei .

$$T_{1/2} = 0.693\,\tau$$

5. Write three types of radioactive decay occur in nature.

1.Alpha decay
2.Beta decay
(i) (β−) decay
(ii) (β +) decay
3.Gamma decay

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6.Alpha decay

Atomic number decreases by 2 and mass number decreases by 4.

$${}^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He$$

$${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

7.Beta minus (β−) decay

Atomic number increases by 1 and mass number remains same.

$${}^{32}_{15}P \rightarrow {}^{32}_{16}S + e^{-} + \bar{\nu}$$

8. Beta plus (β +) decay

Atomic number decreases by 1 and mass number remains same.

$${}^{22}_{11}Na \rightarrow {}^{22}_{10}Ne + e^{+} + \nu$$

9.What is nuclear fission

Nuclear fission is the process in which a heavier nucleus splits into lighter nuclei with the release of large amount of energy.

10. Write the fission reaction of uranium-92 nuclei

$$ {}_{0}^{1}\mathrm{n} + {}_{92}^{235}\mathrm{U} \rightarrow {}_{92}^{236}\mathrm{U} \rightarrow {}_{56}^{144}\mathrm{Ba} + {}_{36}^{89}\mathrm{Kr} + 3\,{}_{0}^{1}\mathrm{n} $$

11.Moderators used in nuclear reactor.

water, heavy water (D2O) and graphite.

12.Control rods used in nuclear reactor.

Cadmium

13.What is Nuclear fusion

Nuclear fusion is the process in which two light nuclei combine to form a single larger nucleus, with the release of a large amount of energy.

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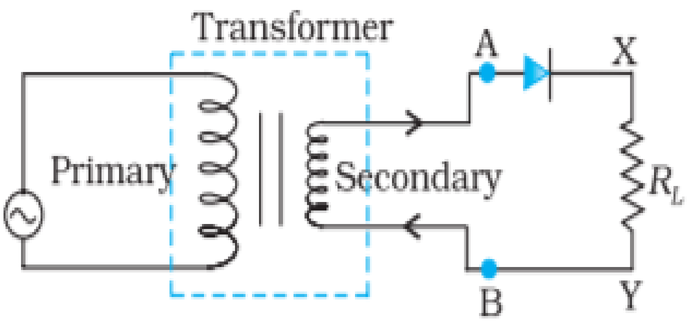
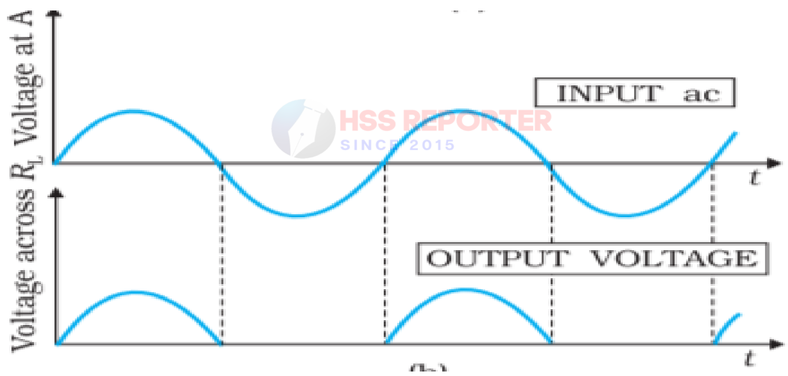
Chapter 14- Semiconductor Electronics: Materials, Devices and Simple Circuits

1.Explain a half wave rectifier Draw the input and output voltage waveforms.



In the positive half-cycle of ac there is a current through the load resistor R_L and we get an output voltage, whereas there is no current in the negative half cycle.



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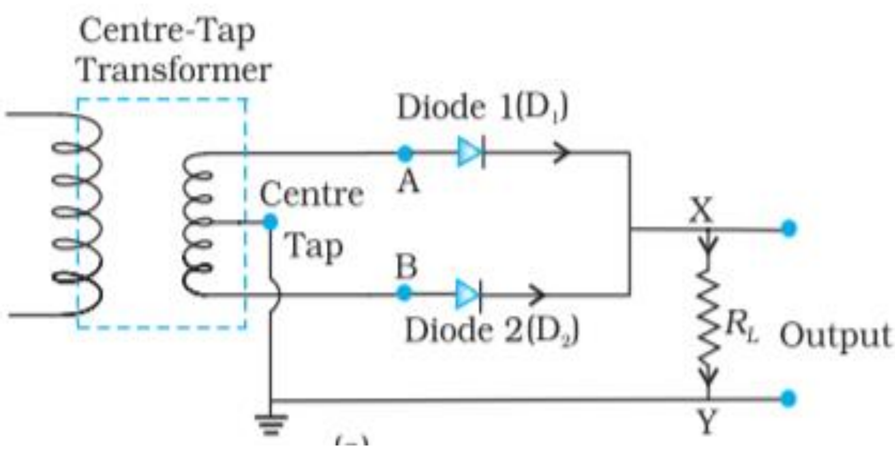
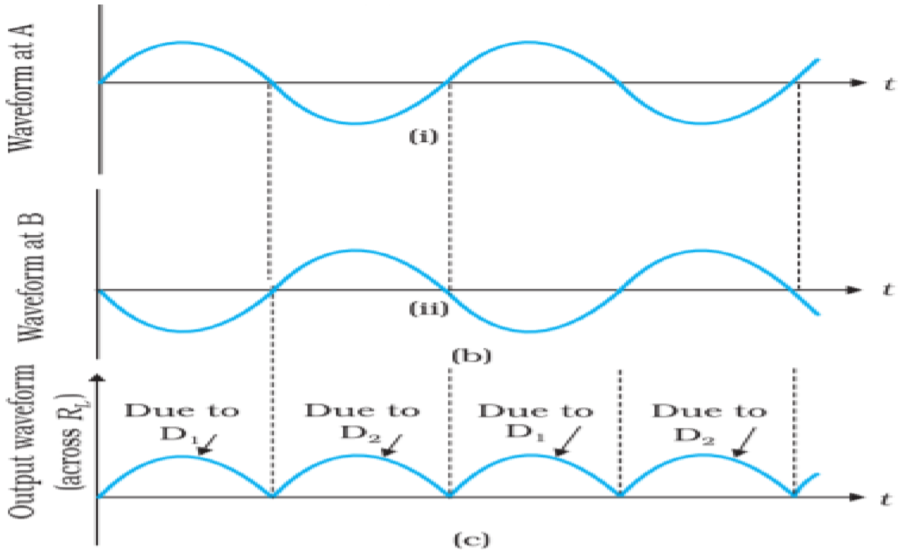
2. Explain a full wave rectifier . Draw the input and output voltage waveforms.



During this positive half cycle, diode D_1 gets forward biased and conducts ,while D_2 being reverse biased is not conducting. Hence we get an output current and a output voltage across the load resistor R_L.

During negative half cycle, diode D_1 would not conduct but diode D_2 conducts, giving an output current and output voltage across R_L in the same directionas in positive half.

Thus, we get output voltage during both the positive as well as the negative half of the cycle



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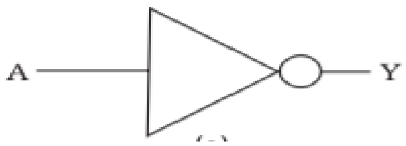
3.Draw the symbol and truth table for NOT gate

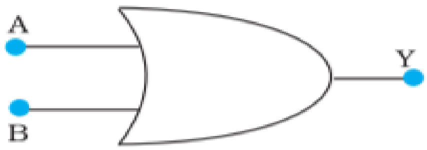
Symbol **Truth Table**



Input	Output
A	Y
0	1
1	0

4.Draw the symbol and truth table for OR gate

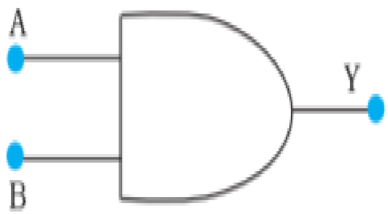
Symbol **Truth Table**



Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

5.Draw the symbol and truth table for AND gate

Symbol

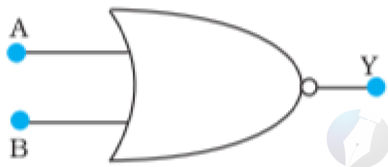


Truth Table

Input		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

6.Draw the symbol and truth table for NOR gate

Symbol



Truth Table

Input		Output
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

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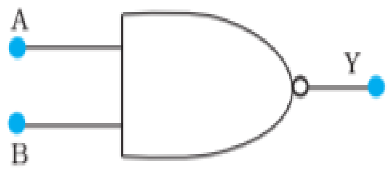
7.Draw the symbol and truth table for NAND gate

Symbol



Truth Table

Input		Output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

8. NAND and NOR gates are called universal gates. Why?

NAND and NOR gates are called universal gates, since using these gates we can realise other basic gates OR, AND and NOT gates.

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